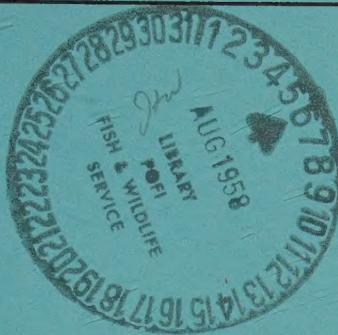


ISSUE TWENTY-TWO
MAY 1958



THE CANADIAN FISH CULTURIST



Published at Ottawa by
The Department of Fisheries of Canada

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1958

CONTENTS

	Page
Some Principles Involved in Regulation of Fisheries by Quota— W. E. RICKER.....	1
Regulation of the Atlantic Salmon Fisheries—C. J. KERSWILL.....	7
Regulation of the Lobster Fishery—D. G. WILDER.....	13
Some Sociological Effects of Quota Control of Fisheries— J. L. HART.....	17
Some Economic Aspects of Control by Quota— W. C. MACKENZIE.....	21

The papers in this issue were presented at a meeting of the Committee on Biological Investigations of the Fisheries Research Board of Canada held at Ottawa in January, 1957, under the chairmanship of Dr. J. R. Dymond, of Toronto.

The Canadian Fish Culturist is published under the authority of the Minister by the Department of Fisheries of Canada as a means of providing a forum for free expression of opinion on Canadian fish culture. In the areas of fact and opinion alike, the responsibility for statements made in articles or letters rests entirely with the writers. Publication of any particular material does not necessarily imply that the Department shares the views expressed. In issuing The Canadian Fish Culturist the Department of Fisheries is acting only as an instrument for assisting in the circulation of information and opinion among people in the fish culture field. Those who may wish to discuss articles which have been published in The Canadian Fish Culturist are encouraged to do so and space will be made available.

Correspondence should be addressed to the DIRECTOR, INFORMATION AND EDUCATIONAL SERVICE, DEPARTMENT OF FISHERIES, OTTAWA, CANADA.

Published under Authority
of
HON. J. ANGUS MACLEAN, M.P.,
Minister of Fisheries

Some Principles Involved in Regulation of Fisheries by Quota

by

W. E. Ricker

Fisheries Research Board of Canada, Biological Station, Nanaimo, B.C.

All kinds of fishery regulations are designed to stop people from catching fish, even when they promise larger catches later on as a reward. Regulations may operate in one of a number of ways: 1. They may reduce the catch of a species at all sizes, or only at some particular range of sizes; 2. They may prohibit fishing in certain places; 3. They may prohibit fishing at certain times of year, or certain times of the day; 4. They may prohibit the use of certain kinds of gear; 5. They may prohibit taking fish in excess of a certain number (or weight) by any one individual, or boat; 6. They may prohibit taking fish in excess of a given total number or weight, each year, from the stock in question.

The motives which lead to these regulations are all, I believe, economic in the broad sense. However they are classifiable in two groups: those which aim at direct economic ends, and those which aim at increasing the general level of potential catch. Among the more direct economic aims may be, for example: 1. a desire to share the catch among as large a number of fishermen as possible (e.g., bag limits in sport fisheries); 2. a desire to restrict the number of individual fishermen or boats so that each can have a desirable net return from his activities (for example, leasing of oyster beds, and restricted licencing of nets or traps); 3. a desire to favour certain types of fishing, or certain groups of fishermen (prohibition of trawling by large trawlers within 12 miles of the coast, in the Maritime Provinces); 4. a desire to spread out landings over the year to promote orderly marketing of fresh fish (separate "summer" and "winter" quotas for prairie lakes); 5. a desire to restrict the duration of fishing so as to avoid stormy weather (prohibition of winter halibut fishing in the north Pacific) or so as to work only when the fish are concentrated and easy to catch; 6. a desire to obtain a more valuable product by increasing the average size of fish caught (special size restrictions on lobsters in certain areas), or by catching fish only when they are of prime quality (for example, salmon or herring before their fat is converted to sexual products).

The second type of regulation, often called *biological*, has to do with obtaining maximum sustained yield from the stock, or some similar objective. Regulations of this type are distinguished by the fact that they try to promote the economic objective of increased yield, or a larger catch per fisherman, by way of a manipulation of the size of the stock or its age composition. In their economic aspects, these so-called "biological" measures tend to benefit all fishermen indiscriminately, rather than the interests of particular groups. They are often described by names that have a certain emotional content, like "protection" or "conservation"¹ or "prevention of depletion".

¹I am not, of course, deprecating conservation. Using the word in its strictest sense, there is a place and a need for conservation of various fishes and of other animals and plants from the forays of man, almost everywhere on the globe.

The actual kinds of biological regulation vary somewhat. With salmon, which in Canada are mostly caught only toward the end of their growth, effort is devoted mainly to getting the best number of spawners on the redds—not too few and not too many—and getting them there at the proper time. With species like cod or flatfishes, where the individual fish can be available over several years of its life, the problem of maximizing yield has two aspects. For any given number of fish entering a fishery, and given amount of fishing gear, a best minimum size of fish caught can be computed from existing rates of growth and natural mortality, which will permit maximum catch from that group of fish. Existing restrictions on net size in the North Sea and parts of the northwest Atlantic are based mainly on computations of this type. However, the amount of recruitment, also, can vary with stock size or average fish size, as can rate of growth and possibly natural mortality rate; and these effects may modify or might even reverse the expected catch trend computed from existing conditions. We need to consider not only best use of available recruits, but also maintaining and increasing the production of recruits; and compromise may be necessary among conditions which favour each goal.

Before leaving these generalities, we might notice that a given regulation may sometimes serve both direct economic purposes and also the less direct economic goals which have a biological background. This is fair enough, as long as there is agreement that both ends are desirable. What is not so desirable, but quite common nonetheless, is for the biological aspects of a regulation—the “general good”—to be made a front for promoting the interests of particular groups of fishermen. I recall how the salmon traps of Puget Sound were abolished in 1935 by a public referendum or “Initiative” in the State of Washington, which had the combined support of the salmon seiners and the sport fishermen. Among the arguments put forth was the contention that the traps were a particularly destructive and pernicious type of gear, that they “didn’t give the fish a chance”, though actually they were taking far less salmon than the seines did. In the same vein, sea fishermen will maintain that it is shameful for salmon to be caught after they get into a river, and river anglers consider it positively sinful to take salmon from spawning beds—though the salmon are just as dead when caught in one place as in another. It would be foolish to conclude from this that all kinds of fishing are equally desirable, from the point of view of economics and public policy: however, each method should be rated on its own relative contribution to income and to satisfaction, rather than on the alleged destructiveness of competing methods.

Characteristics of Catch Quotas

So much for regulation in general. One method of regulation is to establish a catch quota, and at this meeting we are interested in quotas particularly. On the non-biological side, *daily* quotas for individual sport fishermen are a very popular device for sharing the wealth, though quite often they are ineffective because they are made so large that few fishermen ever reach them. Individual boat quotas are also sometimes applied in commercial fisheries, usually by mutual agreement rather than by law, in order to share markets or processing facilities in times of temporary glut.

However, the term quota usually refers to a limit set on the total catch taken from a stock during a season. What are the peculiar advantages and disadvantages of such quotas? Now it happens that one of the most spirited eulogies of quota regulation has been made by Professor F. I. Baranov (1947). He refers to quotas as the "American" system of fishery management, in contrast to the "European" system of closed seasons, closed areas, gear restrictions, etc. Furthermore, his knowledge of and affection for quotas is based on accounts of their operation in two Canadian fisheries—the whitefish fisheries of some of our prairie lakes, and the eastern Pacific halibut fishery which is shared by Canada and the United States. I can do no better for quotas than to quote some of his remarks.

"All restrictions on fishing," says Baranov, "are useful only insofar as they lead, by one means or another, to a decrease in the catch. In that event it is simpler, more logical and more honest to limit the size of the catch directly, without stooping to petty interference with fishing techniques." Further, "once a quota is established, all other restrictions on the fishery merely increase costs for the operators, without doing the fish stocks any good." "The work of regulatory authorities is simplified [by quotas] . . . and it is possible to reduce the enforcement apparatus. The work of the fishermen is also simplified. They can use the greatest fishing power of their nets, and they can devote their means and energy not to multiplying fishing apparatus in pursuit of an impractical level of catch, but in a restriction and rationalization of this apparatus for attaining the highest economic return from the established quota."

Contrasting quotas with other methods, Baranov notes that "properly speaking, the majority of traditional restrictions on fishing are also directed toward decreasing the intensity of fishing." "But," he says, "they do not achieve that goal. Prohibition of one kind of fishing results in the fishermen turning to a different, still legal, one, so that the amount of fishing is not reduced. Establishing a limit for size of nets . . . is followed by an increase in their number. Closure of one region to fishing is compensated by increased activity in another. Introduction of a closed season on fishing means that fishing becomes greater during the remainder of the year."

There is obviously much truth in these various points, and it would be easy to document them by illustrations from many fisheries. Yet anyone who is close to fishery administration knows that regulation by quota is not always and everywhere as simple and as beneficial as Baranov's words make it sound.

An important technical problem is the need for a highly developed statistical system which provides day-by-day information on catch taken, especially as the quota limit is approached. Such a system can be developed, and it has in fact been developed for the British Columbia herring fishery and salmon fisheries, for example; but it is expensive. If fishing success is more predictable, and if the number of boats that will fish can be estimated fairly accurately, then up-to-the-minute statistics are not essential; an estimate of the probable catch per day can be made in advance with sufficient accuracy, and the fishing season can be made of a length to conform to the desired quota.

In some fisheries neither of the above methods of approximating a quota may be available, or there may be other conditions which make an overall quota dangerous or impractical. For example, a quota covering a broad area may lead to overexploitation

of nearby grounds and underexploitation of distant ones: since the fishermen, each competing for a share of the quota, will make their cruising time as short as possible. This can be alleviated by setting individual quotas for individual subareas; but when this is done there immediately arise those problems of supervision and enforcement which quotas are supposed to obviate. Still other special conditions may make the use of overall quotas unrealistic, particularly where successive populations of a migratory fish proceed through a fishing area.

Furthermore, when you get down to cases, the difference between a quota system and other methods of regulation is by no means clear-cut. Even in Baranov's example of the Pacific halibut, we find that the actual regulations specify a certain fishing season or seasons, not a certain total catch for the year. The length of the season is of course estimated to conform to the desired catch; but, ideally at least, *any* regulation of season or time of fishing is made with a view to adjusting the catch to the most desirable level. Thus the difference between the "traditional" methods of regulation, and the so-called "American" method of regulating by quotas, becomes tenuous and indistinct.

However I do not suggest that the distinction disappears altogether. One thing which a quota brings into sharp focus is the question of the productivity of the stock. If a quota is set at 50 million pounds, for example, the first question a fisherman asks is, why is it 50? Why not 60? or 40? For that matter, how do you know that there will actually be 50 million pounds of fish on hand? Such questions are pertinent with *any* kind of regulation. But when a numerical quota has to be announced, they have a special urgency; there is no avoiding them by vague reference to a "need for conservation" or "protection of spawners". I think we can fairly claim as an advantage for quotas, over other types of regulation, that they more urgently demand information on stock size and *productive potential*, and that they stimulate efforts to determine these².

British Columbia herring quotas

I have been asked to indicate the status of the quotas on herring catches in British Columbia, in relation to the general question of regulation by quota. A good general summary of this matter is given by Taylor (1955). Catch quotas were introduced to a part of the British Columbia herring fishery first during the 1936-37 season. Prior to this time important fishing areas east and west of Vancouver Island had been closed to fishing for herring to be used for reduction purposes—the feeling being that there was greater economic return in using the herring for human food. However the demand for food herring had decreased, and the Province consented to wholesale reduction provided a quota was set to avoid possible excessive exploitation. The quotas set were below the known maximum catches but greater than the minimum catches for the areas concerned.

The supply of British Columbia herring varies from year to year, but usually only moderately: in this respect they are intermediate between halibut and salmon. Nowadays only two or three age-groups occur in the catches to any important degree. Success

²Note especially that knowing the size of the stock is not enough. Too much preoccupation with size of stock can lead to the conscious or unconscious assumption that a large stock is an end in itself. Both theoretically and from experience we know that this is not so. It is possible for a stock to be too great to provide maximum yield, as well as too small.

of reproduction varies considerably from year to year—more in some stocks than in others, but nowhere nearly as much as in, for example, the Norwegian herring stocks. If there are two poor year-classes in succession it means poor fishing two to three years later, while successive good reproductions set the stage for an abundant catch. In addition, in certain areas the stock is more vulnerable to capture in some years than in others. Mainly because of this last, predictions of each year's supply are not yet reliable enough to be used to set a special quota in each area for each year in advance; instead there is nominally the same quota for all years.

In practice, when herring are relatively scarce the quota is not taken. When they are abundant, nearly always a quota extension is granted. The result is that the quota sets a limit to the catch only about once in three years, and even when it does, usually only a few days remain in the season and not much more herring could be taken anyway.

However the herring stocks and fishery are far from being unregulated. There exists a closed season during spawning time, which protects the fish at a time when they are massed into very dense schools. Appropriate gear could make very large catches at such times, and could increase the total seasonal rate of exploitation of the stock from the present 45.55 per cent up to possibly 80 per cent, 90 per cent, or even higher.

In summary, the British Columbia herring fishery is producing an excellent annual yield and gives every appearance of being in a healthy state. But it is *not* a good example of the effects of regulation by quota, since the quotas to-day do not often or very greatly restrict fishing: restriction is accomplished by the closed season. However, the quotas may have potential value as a standby, in case pre-spawning fishing were ever to become substantially more effective than it is to-day.

Effects on fishermen and the industry

I do not intend to consider the economic and sociological effects of quota regulation in any detail. However it seems necessary to comment on one of the statements quoted earlier: that the use of quotas makes it possible for the fishermen to restrict and rationalize their fishing, by eliminating gear in excess of what is needed to take the quota. This of course is possible if quotas are set for individual fishermen or boats, and this system has been used in the whitefish fishery of, for example, Lake Winnipeg. A disadvantage, possibly, of this practice is that it may tend to discourage individual initiative among the fishermen (since the more skilful or enterprising ones can take no more than others) and it relaxes normal incentives to improve fishing equipment and to exploit fully the whole area from which a catch can be taken.

On the other hand, if only an over-all quota is assigned and there is no limit on total gear in use, each fisherman is exposed to the full rigours of competition—something he may not altogether care for. The general economic situation is then the same as for other common-resource operations, whose advantages and disadvantages will be evident from the remarks of the speakers who follow.

References

- BARANOV, F. I. 1947. [The American system of fishery management.] Rybnoe Khoziaistvo for 1946, No. 12, pp. 31-34.
- TAYLOR, F. H. C. 1955. The Pacific herring (*Clupea harengus*) along the Pacific coast of Canada. Intern. North Pacific Fish. Comm., Bull. No. 1, pp. 107-128.

Regulation of the Atlantic Salmon Fisheries

by

C. J. Kerswill

Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B.

Since 1949 the research and management programme for Atlantic salmon in eastern Canada has been under review by a Federal-Provincial Co-ordinating Committee. The main objective is to make more salmon available for use by both the commercial and sport fishermen. The various projects and recent results of the joint programme have been described in articles published in the April, 1955, and April, 1956, issues of the Department of Fisheries' monthly publication "Trade News".

Economic Value of the Salmon Fisheries

Wide fluctuations in total annual commercial landings of Atlantic salmon in eastern Canada have occurred since 1870 when the first statistics were published. Peak levels of production usually followed periods of below-average yields at intervals of about ten years. The most recent peak in commercial production occurred in 1930, however, when over 13 million pounds were landed, with a value of over \$4 million. This was followed by a steady decline to a level of 4 million pounds in 1945, no indication of significant improvement by 1949, and a still lower level of 3 million pounds with a landed value of about \$1 million by 1955. From one-half to two-thirds of these total landings have come from Newfoundland, including Labrador. The landings in all parts of the Canadian Atlantic coast have shown a similar trend, and it is interesting that there is a close correspondence between fluctuations in commercial landings here and in the eastern part of the North Atlantic around the British Isles.

There has been widespread concern over this last prolonged depression in commercial landings with its widespread effect on the netsmen, and anxiety about the future of the valuable sport fishery in the rivers. Actually there is no evidence of a general decline in angling catches since 1930, and even more salmon have likely been caught through an increased total rod effort in recent years. Since 1949 improved statistics have been obtained on angling catches, and it is known that at least 75,000 salmon are now taken annually in all the rivers combined. Of these about 45,000 are angled in the rivers of the Gulf of St. Lawrence, 5,000 in rivers around the outer coast of Nova Scotia, 5,000 in Bay of Fundy rivers, 5,000 in Quebec rivers on the north shore of the St. Lawrence, and 15,000 in Newfoundland rivers. Unfortunately it is very difficult to assign a reliable economic value to the sport fishery, where the value of recreation alone accounts for such a large proportion of the total. Judging by the value of comparable sport fisheries in the United States recently estimated by a careful census, our salmon angling is probably worth several million dollars. There is no doubt that the availability of Atlantic salmon for angling in Canadian rivers is a very valuable national asset. This, combined with the commercial fishery, which can be

expected to be worth about \$3 million in normal years, justifies considerable effort to see that the best possible management techniques are employed for this species.

Salmon Life History in Relation to the Fisheries in a Typical River Area

The accompanying figure shows the life history of Atlantic salmon and its relationship to the commercial and sport fisheries in a typical large New Brunswick river system. Over the whole Atlantic coast of Canada, the duration of the fresh water stage varies more than is indicated for this one area.

Spawning

A convenient starting point is the spawning of adults in October and November. Experiments on the Pollett River, N.B., are now indicating that a rather modest number of parents is needed for optimum smolt production. If predatory birds, chiefly mergansers, are controlled it is estimated that about 45 pounds of adult females are needed per average mile of stream 10 yards wide, to give the optimum number of about 200 eggs per 100 square yards of bottom. This applies only to streams which commonly have two-year smolts. For rivers like the Miramichi with typically three-year smolts, about 250 eggs per 100 square yards seem to be needed. This allows for normal fishing effort after the adults have entered fresh water, so the numbers of eggs are higher than are actually required to be deposited in the spawning redds. Studies over the past five years indicate that the Miramichi River has been receiving about this level of spawners.

An important point is that a much lower egg deposition can be allowed if mergansers are not controlled, because these predatory birds will drastically reduce the number of parr to give much lower smolt production than would otherwise occur. To allow for the above levels of spawning without predatory bird control would be expected to lead to a waste of adult salmon.

From eggs to smolts

In the Pollett River experiments now in progress, the survival rate from eggs to fry with three "light" spawnings has averaged 6 per cent, while the survival rate from fry to large, pre-smolt, parr has been 80 per cent. Comparable data for "medium" and "heavy" spawnings are not yet available. It is hoped that the results of these studies combined with similar observations on other rivers will shortly give a relationship between smolt production, egg deposition, and numbers of spawning adults.

From smolts to adults

There are inadequate data yet on the rate of survival from descending smolts to the adult stage when the salmon are taken by various fisheries or contribute to the spawning escapement. Some evidence that the survival rate lies between five and ten per cent has come from our smolt marking experiments and from other investigations. For the Miramichi River the estimated total annual smolt production in recent years has averaged about $1\frac{1}{2}$ million. With such a high mortality in the sea, only 75,000 to 100,000 of this output would survive for use by the fisheries or for spawning.

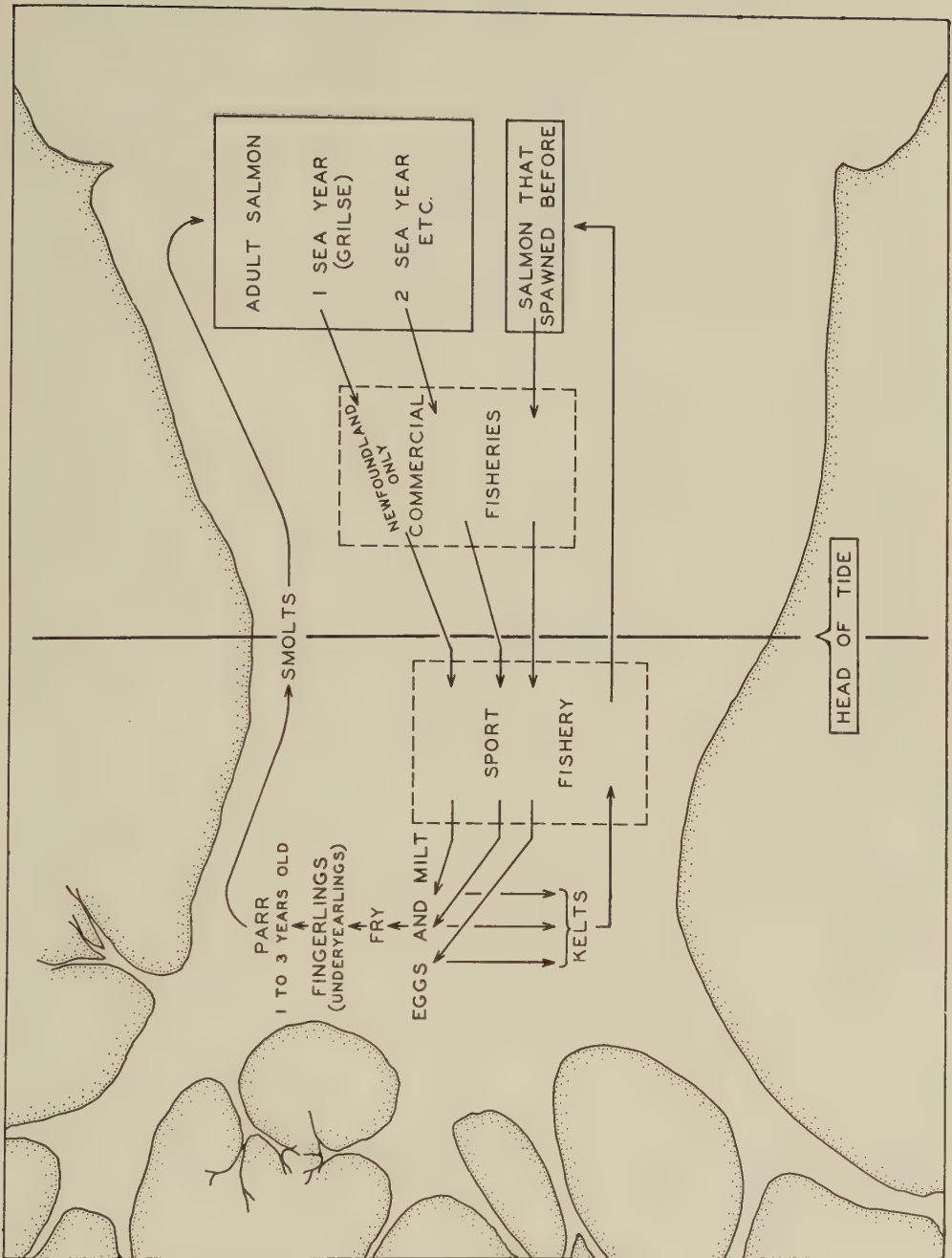


Figure 1.—Life cycle and utilization of Atlantic salmon in New Brunswick, Canada.

Capture by commercial gear

For the whole Canadian coast the gear comprises surface drift-nets operated offshore, inshore fixed trap nets and a few floating gill-nets, while some salmon are taken incidentally in gear set for other species. Traditionally the nets have been set to take adult fish as they apparently move from the feeding areas which are often far away in the sea, towards the native streams to spawn. Reliable information on the capture of adult salmon of known river origin by such gear over a wide area of the coast is now coming from a marking programme involving smolts produced in the Miramichi and Pollett Rivers, N.B., the Port Daniel River, Que., and the Little Codroy River, Nfld. It has been found, for example, that many salmon produced in Maritime streams are taken far away in commercial nets, particularly around the east coast of Newfoundland. Also they may wander into the estuaries of other maritime rivers and be caught there by commercial gear. Of course, many are taken also by the gear set in the estuary of their native river.

There are fishery regulations covering the opening and closing dates of the seasons which are different for different areas of the coast, mesh regulations aimed at protecting small salmon (grilse), weekly close periods to allow fish to escape the nets completely for a couple of days each week, but no quota systems. Most of the catch consists of two-sea-year fish, except around Newfoundland where grilse can still be caught for market in commercial nets. Each year the run of fish into many estuaries is marked by two peaks, one early in the summer and one in the autumn. In some rivers like the Miramichi the late run has by far the most fish, which come in after the commercial season is over. Only early run fish are desired by most commercial fishermen, and at present there is no demand for a fall fishery. As the spawning season approaches, salmon are not considered to be in good condition for the market.

The sport fishery

Upon reaching fresh water areas of the rivers the salmon become available to anglers, who can legally keep both grilse and large salmon. In some rivers, like the Miramichi, grilse comprise about one-half the total angling catch. Other rivers, like those of the east coast of Newfoundland, may provide only grilse angling, while in others large salmon provide the bulk of the angling catch as in some Quebec streams. In New Brunswick alone there is a legal fishery for kelts in the spring. There seems to be no objection to this on biological grounds because very few kelts (5 to 10 per cent) ever turn up again after the first spawning. About 5,000 kelts are taken each spring in the Miramichi River which is now the most popular place for such fishing.

The fishery regulations for angling include opening and closing dates for the season which differ from one area to another depending on the usual time of arrival of the fish, daily and weekly bag limits, and restriction of method to the use of artificial flies when angling for salmon.

Discussion

The primary aim of fishery regulations for Atlantic salmon is to assure an adequate spawning escapement. Obviously most of the existing regulations were put into effect many years ago when requirements for spawning were unknown. Reliable

information on this point is now being obtained for the experimental rivers where concentrated work is in progress. It is hoped that the requirements for many streams can be developed from data obtained on a few typical ones. A useful supplement to these studies is the counting of ascending fish through traps installed in many fishways, and annual surveys of spawning activities on a number of rivers now being carried out by the Conservation and Development Service of the Department of Fisheries.

It seems reasonable to aim at providing, through regulation, for the amount of spawn that will give the optimum number of young under average conditions for hatching and survival. An idea of the amount of variation to be expected from year to year in the smolt production of the same river area is provided by data of recent experiments on the Pollett River. On a ten-mile experimental stretch, ample stocking was provided by planting 250,000 fingerlings in five successive years, with predatory birds controlled. The average smolt production from these five plantings was 20,000; the minimum was 14,000, the maximum was 25,000. This variation amounts to about plus or minus 25 per cent of the basic "capacity" of the stretch to produce smolts.

A very important point concerning regulations to insure adequate spawning escape-ment, is the possibility of early-run or late-run adults tending to produce young salmon that will inherit the tendency to return to fresh water early or late, as adults. If this were the case and if attention were given only to the numbers of young salmon being produced per unit area of stream, the future supply of early-run adult salmon could be inadequate. There is some evidence that such a tendency to return early or late is not generally inherited in Atlantic salmon. Nevertheless, in 1954 the fishery regulations for both commercial and sport fishing were amended to allow more early-run salmon to reach the spawning grounds. It was reasoned that this could do no harm and that it was desirable to be on the safe side until more information could be obtained. This information will start to accumulate in 1957 as the first returns of adult salmon come from an experiment started in 1953. The experiment involves the planting of marked fingerlings of known parentage, in streams which have runs predominantly of the other type as regards time of entry of adults. The time of return of the marked salmon will be compared with the time of return of the native stock.

Most of the fishery regulations for Atlantic salmon have likely been too restrictive in the past, owing to inadequate knowledge. An example of a situation where liberalization of regulations might be desirable is the closing date of the commercial fishing season in the Miramichi River area. Closing the trap-net season on August 31 prevents utilization of most of the total run of salmon here each year, because at least 85 per cent of all the large salmon enter the estuary after September 1. Since 1954, however, abnormal conditions affecting smolt production have been created in the whole Miramichi watershed through extensive spraying of the woodland with DDT against the spruce budworm. The spraying has had such serious effects on parr survival that it is not safe to reduce spawning stocks at this time.

Several years ago when the present research and management programme was being planned it was necessary to assign priorities to a list of projects considered to be worthy of attention in the near future. Almost all the projects have been undertaken

except physiological and behaviour studies which would require special facilities and staff. Quite recently it has become apparent that particular attention should be given to the effects of hydro-electric developments, pollution as from mining operations or DDT spraying, deforestation, and other factors associated with industrialization, on the general behaviour and survival of various stages of salmon. New studies along these lines are now being planned. It is quite possible that the information so obtained will be of great importance in any attempts to manage the Atlantic salmon fisheries by regulation or other means a few years hence.

Regulation of the Lobster Fishery

by

D. G. Wilder

Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B.

Introduction

Canada's lobster fishery is our most valuable inshore fishery on the Atlantic Coast. In recent years the catch has approximated 50 million pounds with a marketed value of 20 million dollars. Almost 20 thousand fishermen fish about two million traps valued at over five million dollars. In the major producing areas inshore fishermen derive a high proportion of their fisheries income from this one species.

Everyone is agreed that conservation of this valuable resource is of primary importance but just what is conservation and what are its objectives? Conservation has been defined as "Wise Use" and a commonly stated objective is to obtain the maximum sustained yield. In marine fisheries the yield is usually thought of in pounds. With staple foods, sufficient production to maintain national nutritional standards is, of course, of primary importance. The lobster, however, is a luxury item that contributes relatively little to our nutritional welfare. Even if our total production were consumed in Canada the per capita consumption of edible meat would be less than one pound per year. The per capita consumption in North America is less than two ounces a year. With such a product it can be questioned whether the maximum sustained yield is as important an objective as the welfare of the 20,000 primary producers.

Regulations

Over the 100 year history of the lobster fishery numerous regulations have been adopted. These have become so complex in detail as to require a special office consolidation for ready reference. Of these regulations the three most important appear to be those that (a) prohibit the sale of egg-bearing lobsters, (b) establish closed fishing seasons and (c) provide for a minimum legal size. To what extent have these regulations affected the yield from the fishery or the welfare of the fishermen?

Protection of egg-bearing lobsters

Lobsters mature when 7 to 12 inches long and the females spawn every other year. The eggs remain fastened to the abdominal swimmerets until they hatch a year later. Regulations prohibiting the sale of egg-bearing lobsters are in general supported by fishermen, particularly in areas where such lobsters are scarce.

Observations in the southern Gulf of St. Lawrence over the past nine years on the newly-hatched, free-swimming larvae show that the hatch varies as much as 2:1. Survival during the one to two month free-swimming period is, however, much more variable—the numbers surviving to the last free-swimming stage varying as much as

40:1. To date it has not been possible in this area to demonstrate any clear relationship between the number hatched and the number that survive the free-swimming period. In this area lobsters mature early with the result that egg-bearing females and larvae are abundant—apparently many times as abundant as in southern Nova Scotia, an area of late maturity where very few lobsters escape the fishery to become mature. In spite of this great disparity in the abundance of mature lobsters and larvae, the commercial production in the two regions is very similar—about 10,000 pounds per square nautical mile. These observations have failed to provide any factual basis for protecting egg-bearing females. Although the regulation may be of little value in improving the yield or the welfare of the fishermen it seems unlikely that it is actually harmful. The regulation is popular with most fishermen, it affects a relatively small proportion of the catch, and the lobsters released become legal when the eggs hatch.

Closed seasons

Closed seasons were originally introduced in an effort to reduce the fishing intensity and so arrest a steady decline in landings during the early 1900's. Later, adjustments in the seasons were made to aid marketing and to permit fishermen to engage in other fisheries or other seasonal occupations. At present in the Bay of Fundy and southern Nova Scotia the season is open for six to $7\frac{1}{2}$ months but along the remainder of the coast for only two to three months. Studies of tag returns, size compositions, seasonal declines in catch per unit effort, days fished, gear set and hauled show that the rate of exploitation is often higher in the short seasons. The fishery has simply adjusted to the shorter season by employing more men, boats and gear. It seems obvious that closed seasons have failed in their primary objective of improving the sustained yield. They have, however, had numerous secondary effects—some good, some bad.

With short seasons fishermen can turn to other fisheries, farming, lumbering etc., and in some areas it is only by so doing that they are able to subsist. Closed seasons have improved the quality of the lobsters in that less than 20 per cent are caught from July to September when they are soft-shelled and slack meated, difficult to hold and ship and give a poor meat yield. Closed seasons are difficult and costly to enforce and supplementary regulations restricting fishermen, boats and gear to one fishing season a year have been adopted. These supplementary regulations have been seriously questioned on sociological and economic grounds. With short seasons persons who have been gainfully employed elsewhere find it advantageous to engage in the fishery when lobsters are unusually abundant. This effectively reduces the catch of the steady fishermen who find it difficult to see the value of restrictive conservation measures when the accruing benefits are divided among individuals who have not contributed.

With year round fishing over half our lobsters would be landed from July to September and would depress an already low summer market resulting from heavy United States production. One possible solution is a universal closed season from July to September to avoid the period of heavy United States production and to

limit the sale of newly-moulted lobsters. With such a season weather and ice conditions would permit from four to nine months' fishing in the various districts. Landings would be concentrated in the early fall.

Size limits

Minimum legal sizes are established with the objective of increasing the sustained yield, either by allowing more animals to mature and so increasing reproduction or by taking advantage of the period where growth is rapid enough to more than offset losses through natural mortality. There is so little evidence of a relationship between the abundance of mature lobsters and commercial production that the prospects of size limits improving the yield through their effect on reproduction do not appear good. There is, however, considerable evidence that sub-legal lobsters grow enough to more than compensate for natural losses. Extensive marking experiments have shown that lobsters near present size limits survive well and as a general rule moult once a year and grow about 50 per cent in weight. In certain warm water areas growth of the smaller catchable lobsters exceeds 100 per cent a year. Size distribution studies show exceptionally high total mortality rates. Extremely high tag returns (general average of 60 per cent) and the rapid seasonal drop in catch per unit effort show that most of the mortality can be ascribed to the very intensive fishery. These observations provide strong support for minimum size limits. There is also the fact that wherever size limits have been observed the commercial catch has improved. On the basis of the available evidence it is concluded that size limits are the most effective means of increasing the yield from the fishery. If this conclusion is substantiated by controlled experiments, work should be extended to determine the best minimum size limits for the major stocks of lobsters.

Economic and sociological effects

There are two market categories for lobsters, the smaller "canners" which are hermetically sealed or processed as chilled meat and the larger "markets" which are sold alive. There is usually a marked price differential with the markets worth considerably more per pound to the fishermen. From the fishermen's point of view the maximum sustained yield should be measured in value rather than weight. There is, of course, the contribution that the actual processing of canner lobsters makes to the communities. Is this contribution great enough to compensate for the lower price to the primary producer?

In the final analysis conservation is action by individuals. It is the individual fisherman who releases undersized or berried lobsters. To be effective, of course, conservation must be practised by all or a large majority of those using the resource. The individual or group of individuals is led to believe and perhaps has a right to believe that he will benefit. In the lobster fishery this is not always the case. In 1947 a group of fishermen at Fourchu, Nova Scotia, agreed to a regulation which required them to release their smaller lobsters to the extent of approximately half their catch. In 1948 they further agreed to limit their traps in the firm belief that they were wasting money in excess effort. The value of the catch increased rapidly to the point where new fishermen were attracted. By 1956 the fleet had increased

80 per cent and the number of traps doubled. The catch per boat has started to decline. At Tignish, Prince Edward Island, fishermen were forced in 1954 to observe an unpopular size limit. Catches have improved and in 1956 the catch per boat was the highest in recent history. Judging from 13 years' records at this port it seems certain that the fleet will increase to the point where the average catch per boat is about the same as previously.

The rather unique features of the lobster fishery—a readily available but limited supply, a heavy demand and high price, and a relatively low capital investment lead to a degree of exploitation and competition that is perhaps unequalled in marine fisheries. Long-term, enthusiastic co-operation in restrictive conservation measures seems unlikely unless fishermen receive more assurance that as individuals they will benefit. Limited licensing is a possible but unpopular solution. Less drastic measures such as increased licence fees, licence cancellation for infraction of regulations, residence requirements and restriction of government loans for lobster boats and gear might ease the situation considerably. Any reduction in boats or gear should increase the net value of the catch.

Possibly our primary objectives in the management of the lobster fishery are (1) discover and apply the minimum size limits that will yield the greatest gross value and (2) reduce the fishing intensity to increase the net value of the catch and give the fishermen who practise conservation greater assurance that they will benefit. The problem involves a complicated interplay of biological, economic and sociological factors and is of sufficient importance to warrant detailed study.

Some Sociological Effects of Quota Control of Fisheries

by

J. L. Hart, Director

Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B.

Recently striking changes have occurred in many of our fisheries. Some of them seem to centre around the management of the fisheries by quota. Most of these changes, when not forced upon us by circumstances, have been economically advantageous. They have, however, strongly affected in one way or another the lives of the people engaged in the fishery. Superficially some of the results do not appear to be improvements. If the well-being of the people is in fact impaired by quota control, it may be appropriate to examine the sociological implications of this tool of management. The following comments point out some of the problems. Some of these may seem to justify investigation by sociologists.

Quota management of fisheries is resorted to in cases where we presumably know how much fish can be removed from a stock without diminishing the contribution of the stock to our economy. It is applied by allowing fishing from an opening date until the amount of the pre-determined quota is caught up. Apparently where we have the required biological information, quotas provide a seemingly logical method of management for maintaining fish stocks at levels where their yield is maximum or otherwise optimum.

Any type of management will have economic and sociological ramifications. Catch quotas are no exceptions. And as in the cases of other means of management economic and sociological effects are inextricably mixed.

My interest in the sociological results of quota regulation was first roused at a public hearing on halibut regulations for the International Fisheries Commission. As background, I might mention that quota regulation of halibut had been followed by a great increase in availability of fish which led to very fast fishing. The good fishing attracted additional fishing efforts. As a result of the high reward for fishing effort, and of the increased effort, the quotas were (and are still) caught up very quickly. The incident involved the protest of a veteran Norwegian skipper. I wish I could accurately reproduce in full his dignified but perturbed statement. Instead I shall have to provide a poor paraphrase—something like this: "They say that the halibut is being conserved and perhaps it is. I don't know. I do know that before the halibut was conserved and I worked on the schooners I used to fish halibut nine months of the year and make a decent living. Now the season is so short a boat can't catch enough fish to provide a year's income. So I have to turn to working on salmon packers and other things that don't suit me."

So much for our Norwegian friend. He said enough to make it clear that he had suffered severe vocational dislocation as a result of management policies imposed to increase the growth of the halibut biomass. For him it was an important matter.

It seems that sociological stresses result from quota regulation because the regulation accentuates competition among fishermen on the grounds. In some cases there

are co-operative aspects to operations within fishing fleets so that for any situation of fish density and distribution there may be an optimum amount of fishing effort. However, fishermen are always in competition with each other. The fish caught and boated by one fisherman are no longer available to his fellows. However, under quota regulation competitive effects are reinforced. The fish landed by one fisherman reduce the chances of his competitors (and of himself, too, for that matter) of catching the fish which remain in the water. The situation could be approximated under some circumstances where fishermen were in competition for markets, but such occurrences are not common in stabilized fisheries.

The competition leads to an hectic scramble for fish, inordinately long hard working days, perhaps taking unwise chances, near financial disaster to the individual from breakdowns in gear and equipment or from temporary illness. To me these things do not seem good from the point of view of the fishermen involved.

It is more difficult to assess the effects of concentrated production on the economics of fishing. While it seems likely that much uneconomic expense is incurred for competition, there must be real advantage in the mechanization that is encouraged.

The situation for packers and secondary handlers of fish and their shore crews is also difficult to assess. To do so one must weigh the advantages of concentrated predictable operating seasons and their evident economies and rewards against the disadvantages of general rush, crowded facilities, and overworked crews. The effects of congestion and delay on the quality of the fish placed before the consumer might also be considered as a sociological result.

The main sociological effect of quotas would appear to be the discouragement of specialized full time fishermen or of fishermen who specialize in one particular fishery. The fisherman is forced into other fisheries or other occupations in order to maintain his position in society. To some very worthy people this is a most unwelcome development. Whether it is actually bad or not would appear to be a problem for the sociologists. If bad, it must be decided whether to endure the shortcomings so as to enjoy the advantages of a tidy method of management, or to modify the management method to adapt it to human needs.

Another and related effect arises from the very productive fishing each year at the beginning of the quota period. This encourages many fishermen to take part in harvesting the resource. Some of them are part time fishermen or men who are only moderately well qualified for the work. Their participation adds money and variety to their own lives. The fish they catch, however, are taken away from the potential landings of professional fishermen.

Some of the foregoing remarks may suggest basic antagonism to quotas as a method of management. There is no such antagonism. Management of a fishery is complicated and none of the applicable tools is perfect. I recognize that quotas also have shortcomings.

We must realize also that quota control shows strongly features which are present in some other devices of management. For example, seasons, whether imposed by regulation or by the availability of the fish, when the size of the exploitable stock is limited, may have similar effects.

In closing I might add that trial has shown that the headlong exploitation stimulated by quotas even has some disadvantages from the point of view of maintaining the fish stock. The halibut fishery—opening intensively at the beginning of the growing season for the fish—derives little advantage from the growth of the current year. In addition intensive fishing for halibut takes the quota before all parts of the stock are fully available and thus failed to make complete use of the resource until special adjustments were invoked. To me it seems that these biological defects in the quota system resemble what I regard as the sociological shortcomings. Each defect arises from ignoring the complexities of its subject matter.

Some Economic Aspects of Control by Quota

by

W. C. MacKenzie, Director,
Economics Service,

Department of Fisheries of Canada.

The optimal allocation of resources in the fishing industry has been discussed in several recent papers¹ and an international gathering² to discuss the subject has also taken place. In the following notes, an attempt is made to present the gist of these discussions with particular reference to catch quotas as an instrument of fishery management policy.

In view of the interests of the present meeting, this question is approached here in its relationship to fishery conservation. Conservation may be defined, in economic terms, as postponement of the use of a resource. Its rationale is similar to that of the investment of capital generally: postponement of utilization is expected to result in a larger supply being available at a future time.

As applied to the fisheries, it follows that the optimum degree of utilization must be conceived of as a time-function of some kind, i.e. a catch per unit of time. Achievement of this optimum involves a synthesis or reconciliation of the dynamics of fish populations, the rate of withdrawal from the stock (by fishing) and the time-preference schedule of the community concerned (or the rate of interest on invested capital). How may such a complex objective be realized?

Let us consider first of all the nature of the principal instrument for its realization, viz. the primary fishing enterprise. That is, the unit of ownership and management—the two functions are normally combined in the same person or group—operating fishing craft with the accompanying gear and making the first sale of the fish taken. These units range in size from single own-account fishermen to relatively large firms (or divisions of firms) operating fleets of several vessels.

Generalization, concerning such things as the shape of supply curves and the variability of labour and capital factors for primary fishing enterprises, is seldom possible—even within a single country, and especially on an international basis. At least one characteristic is exceedingly persistent and widespread, however. That is the sharing, or “lay”, system of remuneration. Returns to both capital and labour factors are based on prearranged shares in proceeds from the sale of the catch. There is no return to the resource factor, i.e. rent. We’ll return to this in a moment.

¹Crutchfield, James, A., “Common Property Resources and Factor Allocation”, *The Canadian Journal of Economics and Political Science*, vol. 22, no. 3.

Gordon, H. Scott, “An Economic Approach to the Optimum Utilization of Fishery Resources”, *The Journal of the Fisheries Research Board of Canada*, vol. 10, no. 7; “The Economic Theory of a Common-Property Resource: the Fishery”, *The Journal of Political Economy*, vol. LXII, no. 2.

Scott, Anthony, “The Fishery: the Objectives of Sole Ownership”, *ibid.*, vol. LXIII, no. 2.

²The Round Table on Fisheries, under the sponsorship of the International Economic Association, convened at Rome, Italy, Sept. 13-18, 1956.

The ubiquity of the share system is related, apparently, to the fact that it permits the peculiar risks incurred in fishing operations being shifted or spread to some extent. For that reason, the system is thought in some quarters to encourage investment—in expansion or innovation, for example. On the other hand, because of its comparative rigidity, it is sometimes held to have the opposite effect. On the whole, its significance in this respect does not seem to be great—at least in the Canadian milieu, where renegotiation of shares (to facilitate adaptation to technological change) may be accomplished usually without difficulty.

Of very great significance, however, is the point we touched upon a moment ago: the absence of a rental return in the fishing industry. This arises out of the fact that fisheries, in contrast with most other sectors of the economy, are exploited generally under conditions of tenure which make the resource common property. Being unowned—indeed impossible of ownership, probably, in most cases—the resource cannot yield a rent. This may be explained as follows.

Let us suppose that, in the case of a particular fishery, supplies have been drawn from the more accessible and/or richer grounds at relatively constant costs. At some point, as the demand for the products of the fishery grows, operations will be intensified beyond the constant-cost level, or extended to more distant and/or less rich grounds, or both—resulting in higher costs at either the intensive or extensive margins. Under these conditions, if, as in the case of land resources, for example, the grounds were possible of ownership, an income increment (known as rent) would accrue to the owners of the more accessible and richer ones.

Now, since total cost tends to equal total revenue (by definition, as it were), the absence of rent (explicit or implicit) results in a gap that may be filled by an increase in capital costs. In short, the industry probably has a “built in” tendency toward over-capitalization.³ Over-capitalization represents a misallocation or mal-allocation of production factors. The effect is to dissipate, in excess capacity⁴ (numbers of fishing craft with their complement, etc.), any increase in aggregate returns to the industry.

What are the implications of all this for control policy? The above outline probably simplifies drastically—not to say vulgarizes—events in the real world. Nevertheless, insofar as it does approximate reality, it has very important implications for our problem.

Assuming, as we may in normal circumstances, a continuous secular growth in demand, the imposition of restrictions on the catch, i.e. a quota or the like, designed to maintain the fish stocks at or restore them to a predetermined level, will be followed by a rise in price and consequently in aggregate returns. The gap mentioned earlier will be widened and the tendency toward development of excess capacity will be strengthened. In other words, the quota will be filled with successively larger numbers of vessels, each taking fewer fish in a shorter period of time.

The effect is not only to waste resources in over-capacity in the case of the fishery under quota. The development of a fleet capable of participation in other fisheries

³This applies to the industry as a whole and, as shown later, such a tendency is compatible with under-capitalization in the units of the industry, i.e. in individual fishing enterprises.

⁴The stand-by capacity required to provide for variation in raw-material supply and the flow of distribution is, of course, a different matter altogether.

during the "off-season" will be fostered. This tends to generalize over-capacity by forcing enterprises in the latter fisheries to diversify operations and equipment also.⁵

The impairment of efficiency, from the economic and social point of view, extends beyond the primary fishing industry and into the secondary and tertiary (or trade) phases of the industry. The shortening of the operating season increases overhead costs (per unit of output) in handling and processing. In addition to higher direct costs, the prolonged storage of fish products—required to adjust concentration in the supply period to the comparatively regular flow of distribution—results often in serious loss of quality.

The extent to which these tendencies are realized in practice may be illustrated from the recent history of the Pacific halibut fishery—perhaps the outstanding example of a fishery under quota control. During the past 25 years or so, while the catch of Pacific halibut increased by about 20-25 per cent, the number of vessels engaged in the fishery increased by some 120-125 per cent. The figures understate the increase in fishing intensity, since no allowance is made for the growth in productivity resulting from improvements in design, construction, power and equipment with electronic fish-finding and communication devices.

At the same time, the fishing season has been reduced to less than ten per cent of its original length on one of the principal grounds and to about twenty per cent on another. As a concomitant of this, over eighty per cent of the catch is now frozen as compared with about forty-five per cent at the beginning of the period mentioned.⁶

It may be said too that, according to estimate, about one-third of the Pacific halibut fleet is idle between seasons. Some proportion of the vessels that do obtain employment, doubtless, would be under-utilized in operations for which they are imperfectly fitted.

A quota or similar limitation on the catch, below the level that would be forthcoming on a free market, must also have an important influence on price formation at waterfront or dockside markets—through its effect on the supply function of the primary producers. In the short run at least, supply will be inelastic as to price. A reduction in price will tend to result in a longer season, rather than a shorter supply—assuming our earlier analysis to have some validity. In fact, the supply function would become elastic only if prices fell to the point where the attraction of occupational alternatives reduced fleet capacity below the level at which the quota could be filled by the remaining vessels fishing on a full-time basis.

The further implications of this kind of supply situation would depend on the organization or structure of the dockside markets. In perfectly competitive markets, buyers' margins would be minimized and the fullest development of over-capacity in primary production would be encouraged. Completely monopsonistic markets⁷ would lead to opposite results: excessive costs (due to the existence of over-capacity) would be minimized, but at the expense of equitable distribution of income. The actual position, of course, lies somewhere between these extremes.

⁵Under certain conditions, of course, overall efficiency may best be served by the development of flexibility in fleet operations—as, for example, when seasonality or relative price changes make some mobility among different fisheries desirable—but that does not affect the principle here.

⁶Technological progress in fish processing and marketing has contributed to this development, of course.

⁷That is, markets dominated by a single buyer.

Enough has been said to indicate that quota control may involve substantial diseconomies, both internal and external, for the fishing industry. Can anything be done about it? It is probable that a program restricting the catch to a level consistent with, say, maximum sustainable physical yield would not deviate seriously from the social optimum if inputs could also be controlled. Such control would mean restriction on entry to the fishery or fisheries involved.

To accomplish this, since, in most cases, private ownership of fishery resources is out of the question, it has been suggested that the state assume a property right in these resources and collect a rental for the privilege of access to their use. The most efficient fishing enterprises would be able to offer the most rent (in the form of a share of the catch or of an absolute sum of money) and the least efficient enterprises would be eliminated from the industry.

With perfect competition, all the rent would accrue to the state and efficiency would be maximized. Under less perfect conditions, the number of privileges would have to be limited more arbitrarily on the basis of some calculation of the (fully-utilized) capacity needed to fill the quota within the period in which fishing operations normally are possible.

In any event, competitive bidding for fishing privileges would be necessary at intervals to facilitate the movement of capital and labour into and out of the industry. A market in such privileges might arise, under certain conditions, as enterprises changed hands or engaged in different combinations of activity. If there were no need periodically to change the number of privileges, this market could be permitted to allocate them.

As to what should be done with the rents collected, these might accrue to the state as landlord, or, at the outset, they might be used to resettle or compensate displaced fishermen, or, later on, they might be used for purposes like research and protection for the controlled fishery or fisheries. Redistribution to the privileged fishermen, another possibility, would probably result in their being discounted in the application for privileges.

Despite the advantages of this scheme, there are formidable obstacles in the way of its implementation. We need not be too greatly concerned, perhaps, with the strengthening of the fishermen's bargaining power vis-a-vis the fish buyers. Nor need consumers be adversely affected, if, as seems likely, the ability of a producers' monopoly to raise fish prices is limited by cross-elasticities of demand or substitutability among the group of animal protein food products. Producers excluded from the fishery or fisheries, and thus forced to liquidate investments in unfavourable circumstances, could be compensated as already suggested.

Insurmountable difficulties, however, might arise in the case of international fisheries. Since total production costs include the "opportunity" incomes of fishermen, countries with a low level of living would tend to pursue a more intensive fishery than others to achieve an optimum degree of exploitation of a given resource (fish stock)—the optimum being defined as the maximum net economic yield or, in simplified terms, as the maximum difference between total production costs and total value of catch. There would be no one unique optimum level of fishing intensity, therefore, for a resource that is subject to international exploitation—there might be several. If so, agreement among the countries concerned to a system of control like the one described here would probably be precluded.

CORRECTION

In Issue 21 of "The Canadian Fish Culturist," published December, 1957, the following corrections should be noted:

Under "Literature Cited"—page 17, line 2, *for* "000-000" *read* "19-23", line 4, *for* "000-000" *read* "1-6"; page 23, line 2, *for* "Issue VI, pp. 00-00" *read* "Issue 21, pp. 7-17", line 4, *for* "Issue VI, pp. 00-00" *read* "Issue 21, pp. 1-6", line 6, *for* "No. 62, pp. 17-2" *read* "No. 62, pp. 17-23"; page 31, line 7, *for* "No. VI, pp. 00-00" *read* "No. 21, pp. 7-17", lines 8-9, *for* "No. VI, pp. 000-000" *read* "No. 21, pp. 19-23".

On page 20, Table I, headings for the last two columns should read:

Survival from	
Under yearlings	Eggs
100%	6%
54%	4%
—	—

